AGRY 515 2012

- Classification by Function
- N Assimilation
- Ammonium Assimilation
- N Structural Roles
- Ammonium Vs Nitrate Nutrition

Table 1. Group 1: Structural components of biological compounds (carbohydrates, proteins, lipids, nucleic acids) and intermediates of metabolism.

Element	% DM	Major Functions
C	44	Components of organic compounds
H	6	Components of organic compounds
O	44	Components of organic compounds
N	2	Amino acids, proteins, coenzymes, nucleic acids
P	0.5	Sulfur amino acids, proteins, coenzyme A
S	0.4	ATP, NADP, intermediates of metabolism (e.g. sugar phosphates), membrane phospholipids and nucleic acids

Table 2. Group 2: Enzyme activators: elements required for the activation of specific enzymes.

Element	% DM	Major Functions
K	2.0	Activation of ~60 enzymes (e.g. pyruvate kinase). Essential for protein synthesis. Responsible for turgor in turgor-based movements in of guard cells in leaves
Ca	1.5	Enzyme activator (e.g. α-amylase, membrane ATPases). Essential for membrane permeability. Associated w/ pectins in cell walls.
Mg	0.4	Activates numerous enzymes (esp. ATP: phosphotransferases). Component of chlorophyll.
Mn	0.01	Activates IAA oxidase, malic enzyme, isocitrate dehydrogenase. Essential for photolysis of H_2O (pos. via redox changes: $Mn^{2-} \rightarrow Mn^{3-} + e^-$)

Table 3. Group 3: Redox reagents: elemets that undergo reduction / oxidation (redox) reactions by virtue of multiple valance states

Element	% DM	Major Functions
Fe	0.015	Participant in cytochromes ($Fe^{III} + e^- \leftrightarrow Fe^{II}$)
Cu	0.002	Participant in cytochrome oxidase and plastocyanin ($Cu^{II} + e^- \leftrightarrow Cu^{I}$)
Mo	0.002	Reduction of NO_3^- by nitrate reductase, reduction of N_2 by nitrogenase of free living and nodule bacteria ($Mo^{VI} + e^- \leftrightarrow Mo^{V}$)

Table 4. Group 4: Elements of uncertain function.

Element	% DM	Major Functions
B	0.003	Thought to be important for membrane activity. Root growth very susceptible to deficiency
Cl	0.01 – 2.0	Osmosis, charge balance, photolysis of water
Si	< 20	May serve as a strengthening agent in *Equisetum* and the grasses. Also thought to reduce transpiration.
Na	0.5 – 10.0	Requirement for plants using C_4 photosynthesis (including CAM plants). Source of turgor for halophytes.

Figure 1. Overview of N Uptake and Assimilation in Roots and Shoot of Higher Plants

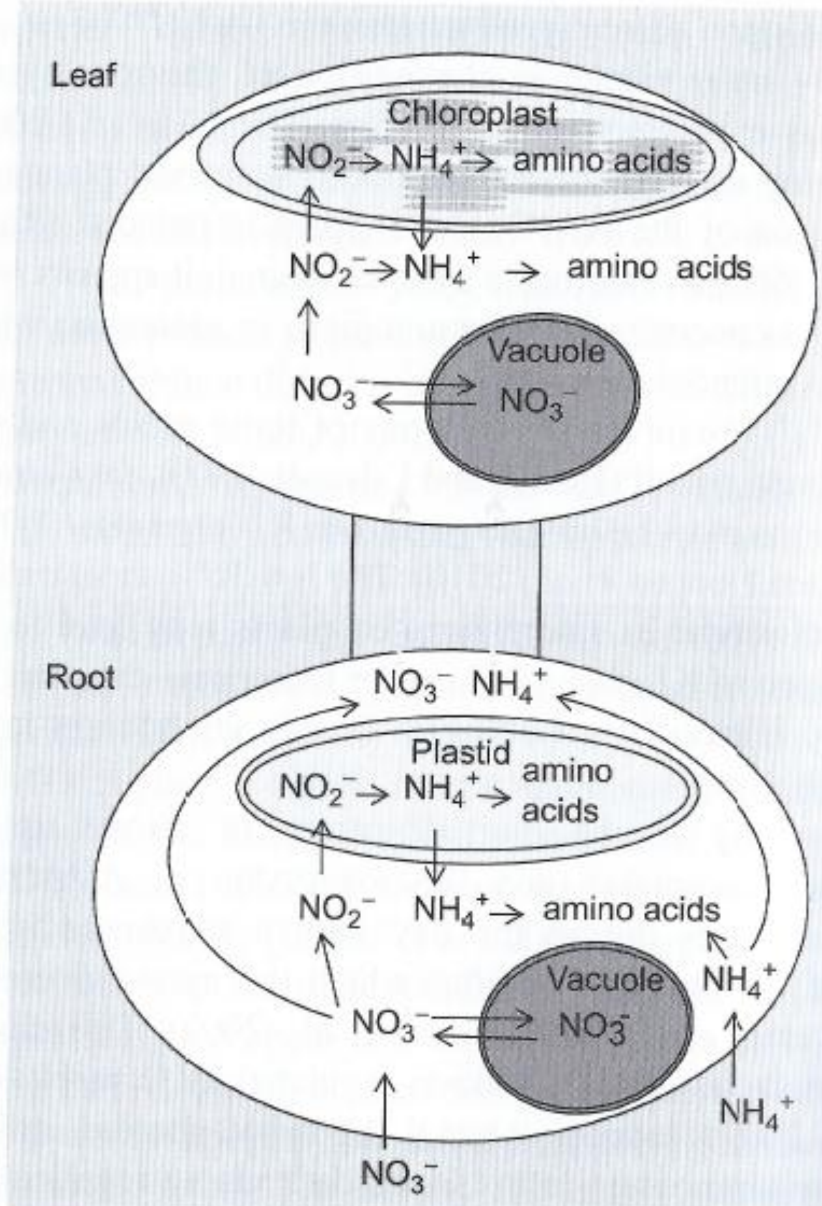


FIGURE 6.6 Overview of N uptake and N assimilation in plants.

Fig. 2. Uptake and Compartmentalization of Nitrate and Nitrite in Leaf Tissues

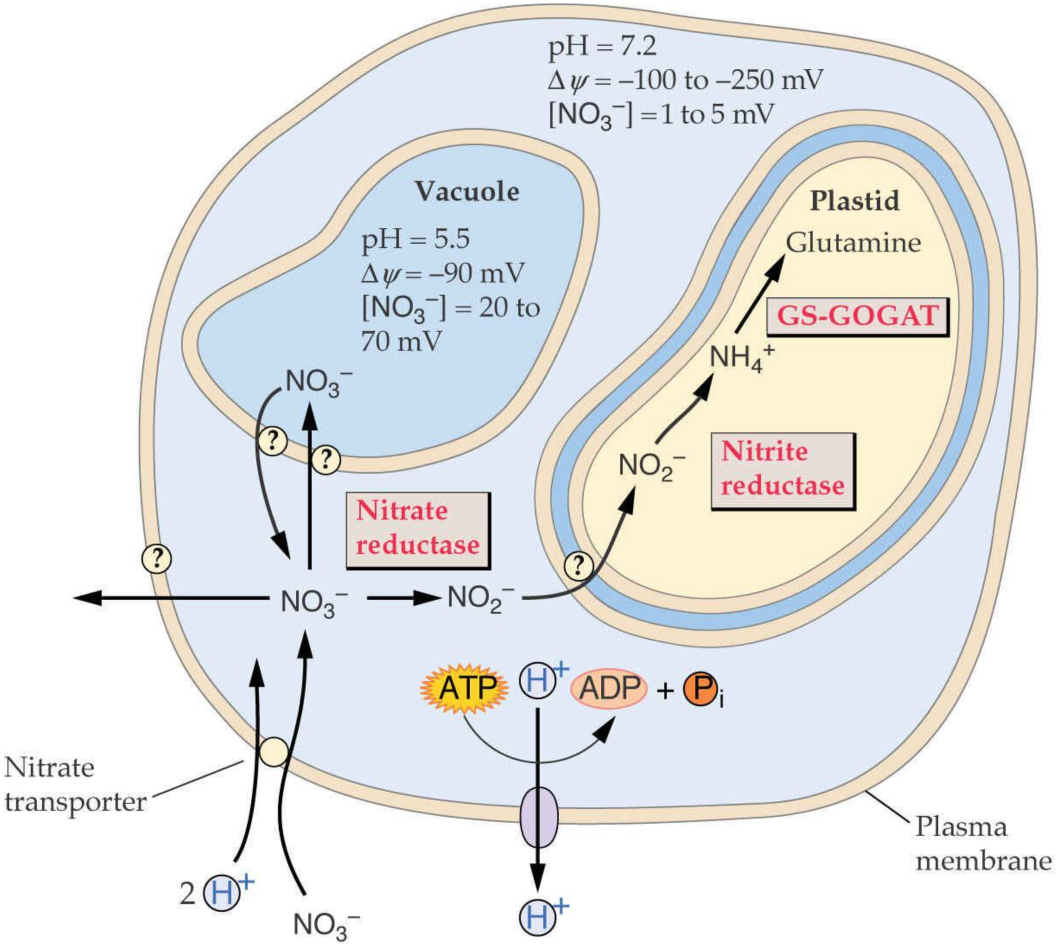
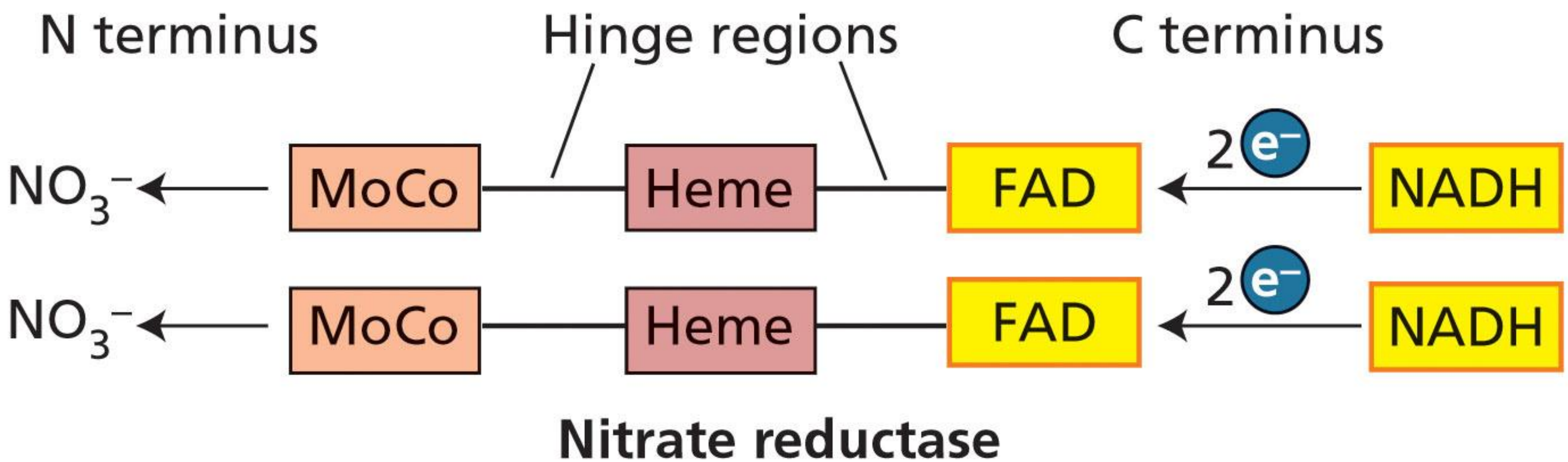
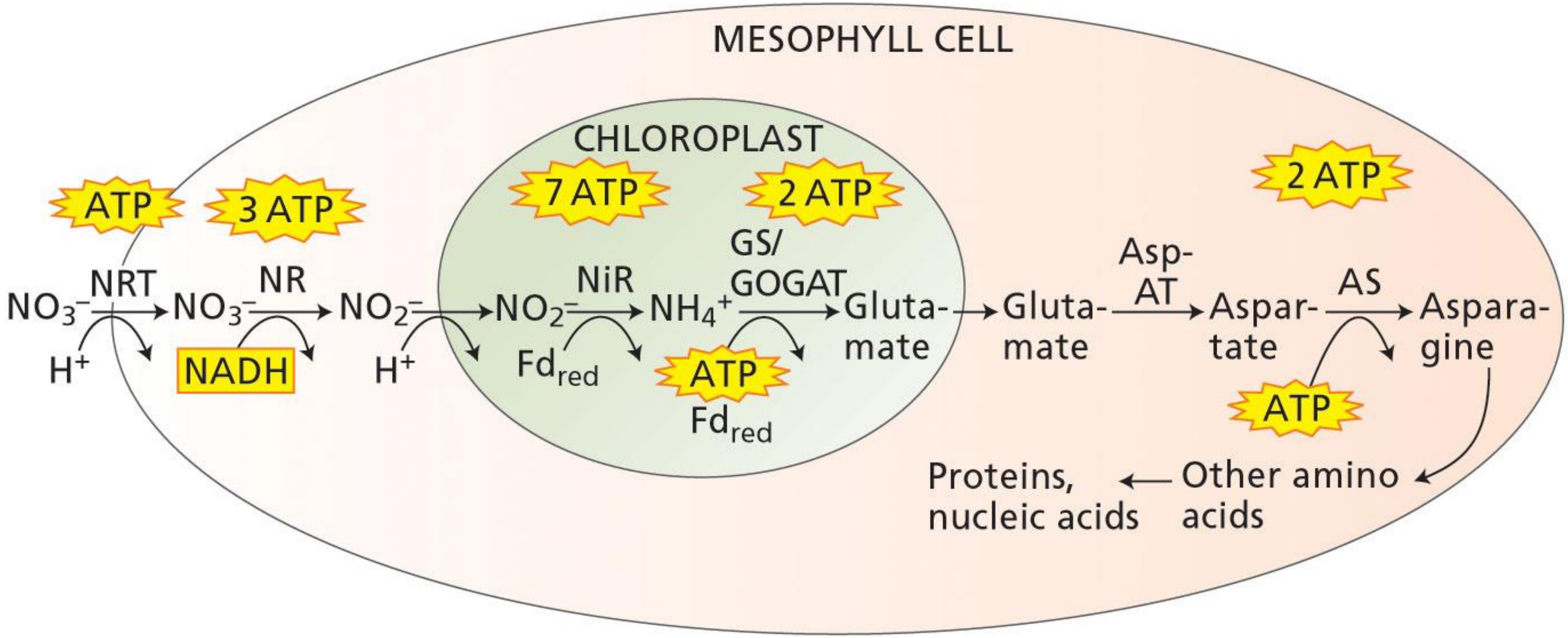


Fig. 3. Model of Nitrate Reductase Dimer Showing the MoCo Complex and NADH as the Source of Electrons



PLANT PHYSIOLOGY, Third Edition, Figure 12.3 © 2002 Sinauer Associates, Inc.

Fig. 4. Summary of Nitrogen Assimilation in a Plant Leaf Cell



PLANT PHYSIOLOGY, Third Edition, Figure 12.19 © 2002 Sinauer Associates, Inc.

Fig. 5. Reduction of Nitrite to Ammonium in Chloroplasts Using Electrons Provided by the Light Reactions of Photosynthesis

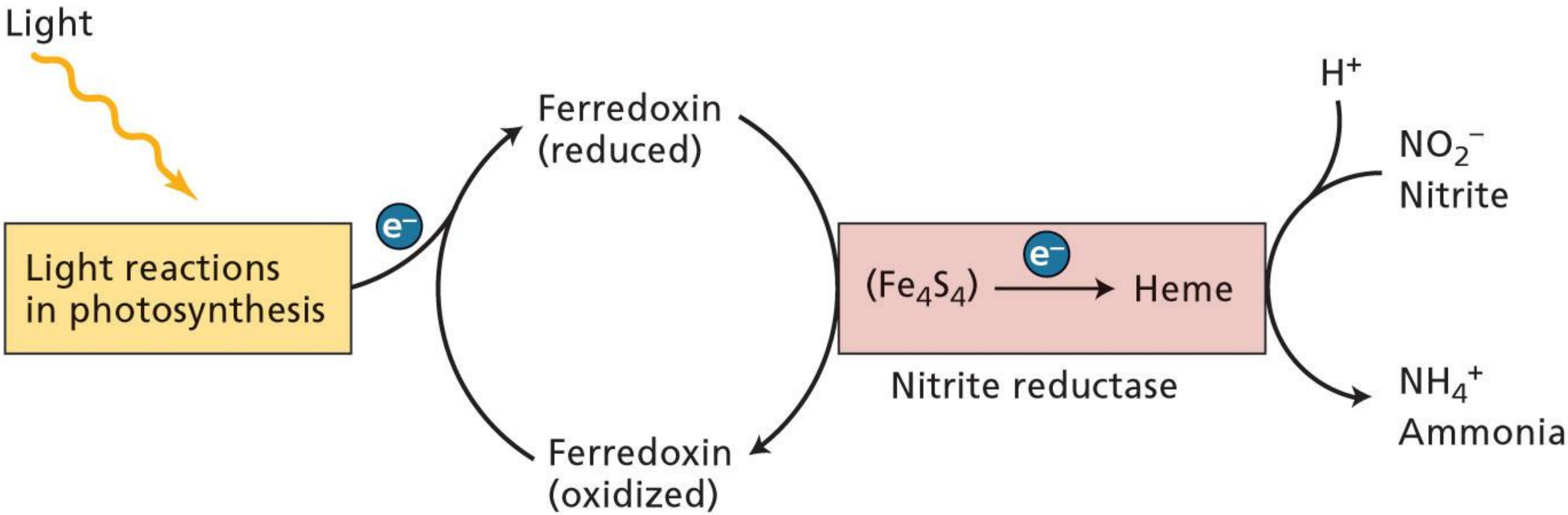


Figure 6. Nitrate Reductase Activity is Reduced in Darkness so NO_2^- Does Not Accumulate

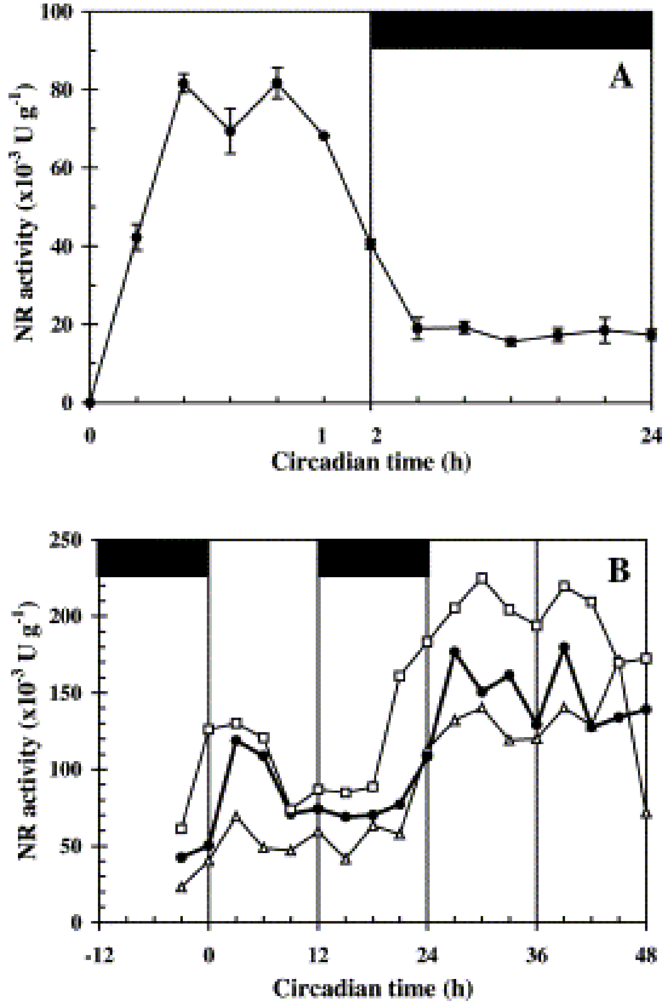
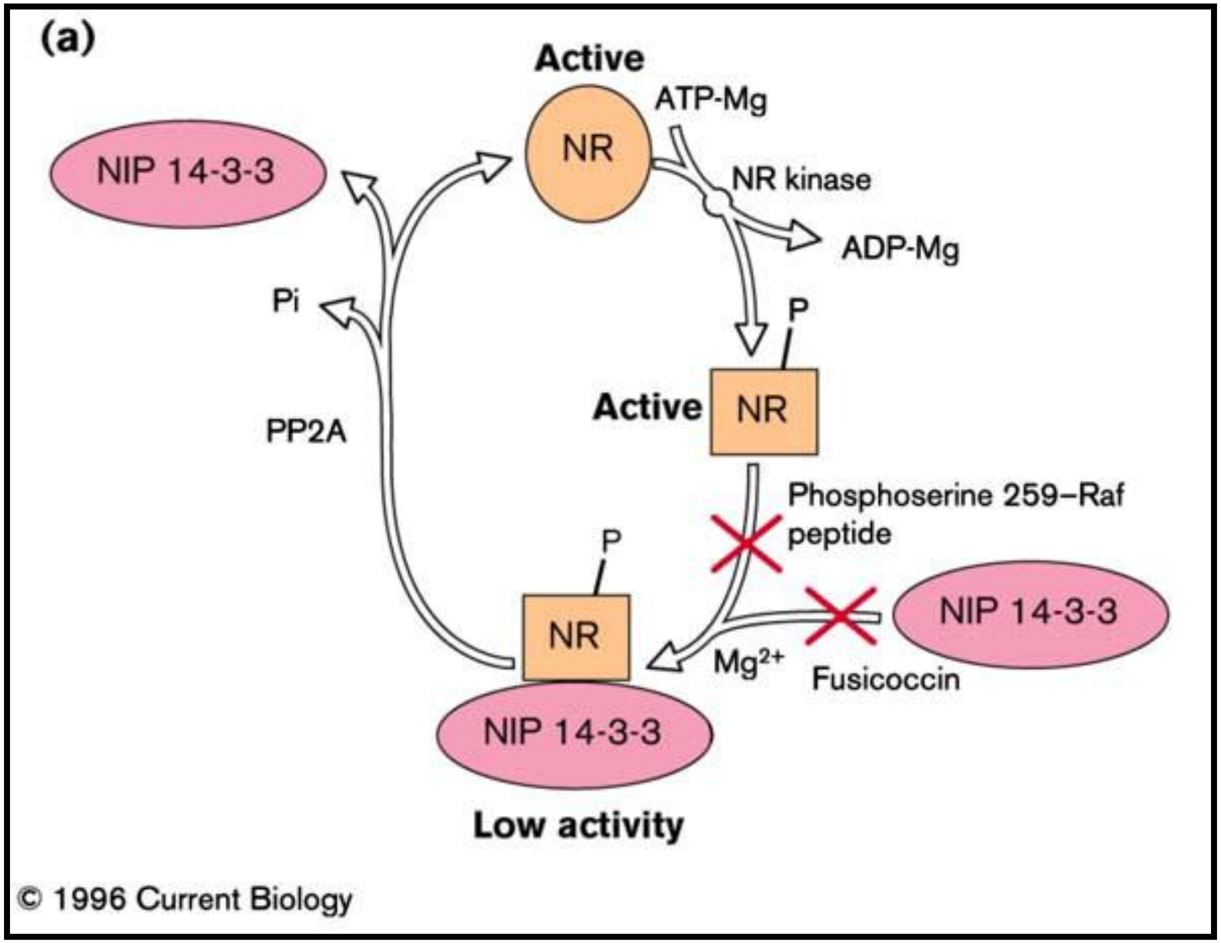


Figure 7. Light Regulation of Nitrate Reductase via Phosphorylation/De-phosphorylation



Regulation of spinach nitrate reductase (NR) by reversible phosphorylation and NIP 14-3-3s. NR from spinach leaves is converted to its low-activity form (for example, in the dark) by phosphorylation at Ser543, and subsequent interaction with NIP 14-3-3. It is the interaction of NIP 14-3-3 with phosphorylated NR that is responsible for inhibition. Divalent cations and an intact amino-terminal tail on the NR and are both essential for the NIP 14-3-3 interaction. Reactivation can occur by dephosphorylation of NR with PP2A and/or dissociation of the NIP 14-3-3s.

Fig. 8. Stimulation of Nitrate Reductase mRNA and Enzyme Activity in Leaves and Roots of Barley By Nitrate Addition

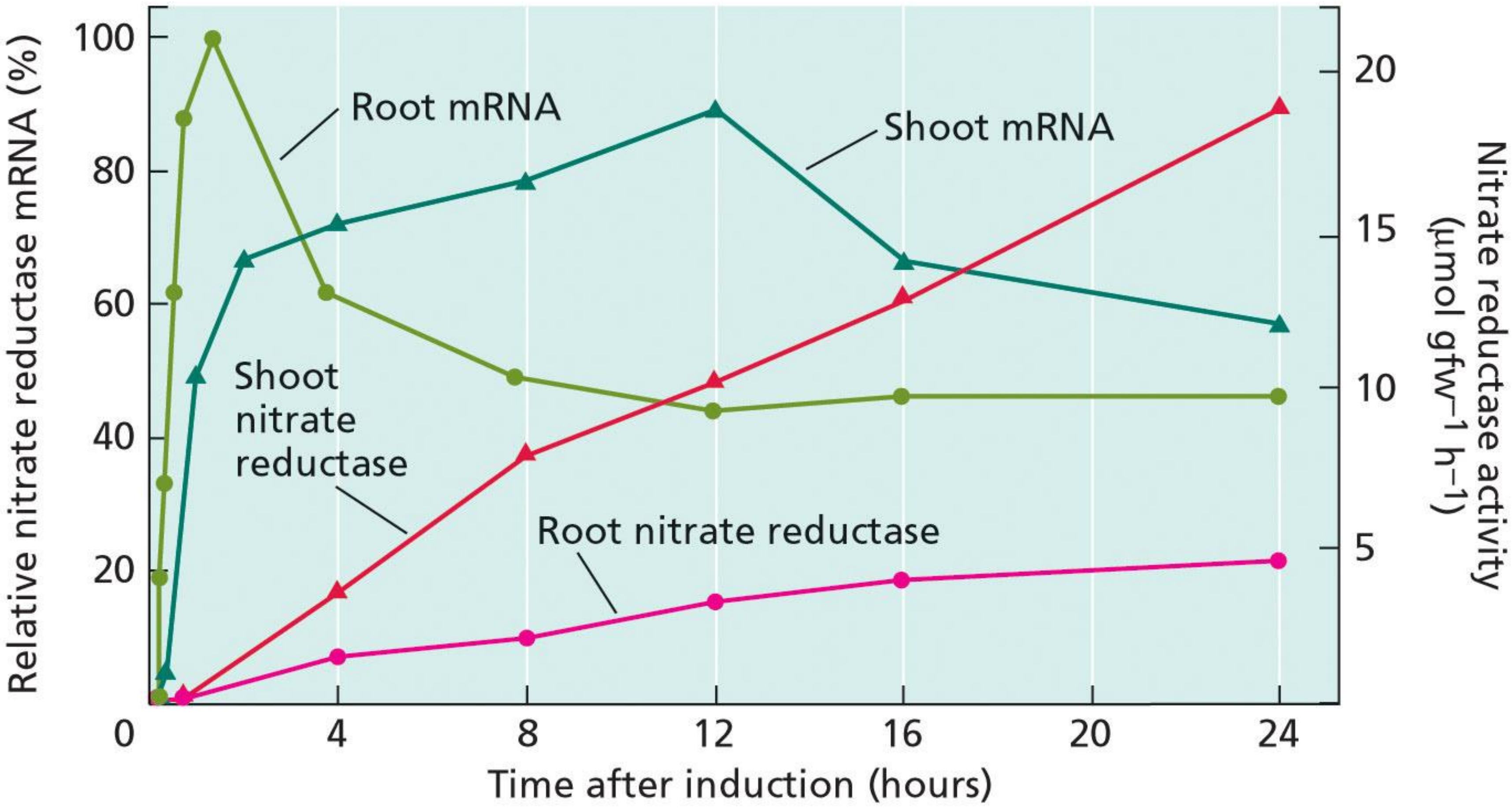


Fig. 9. The GS-GOGAT Pathway for Ammonium Assimilation

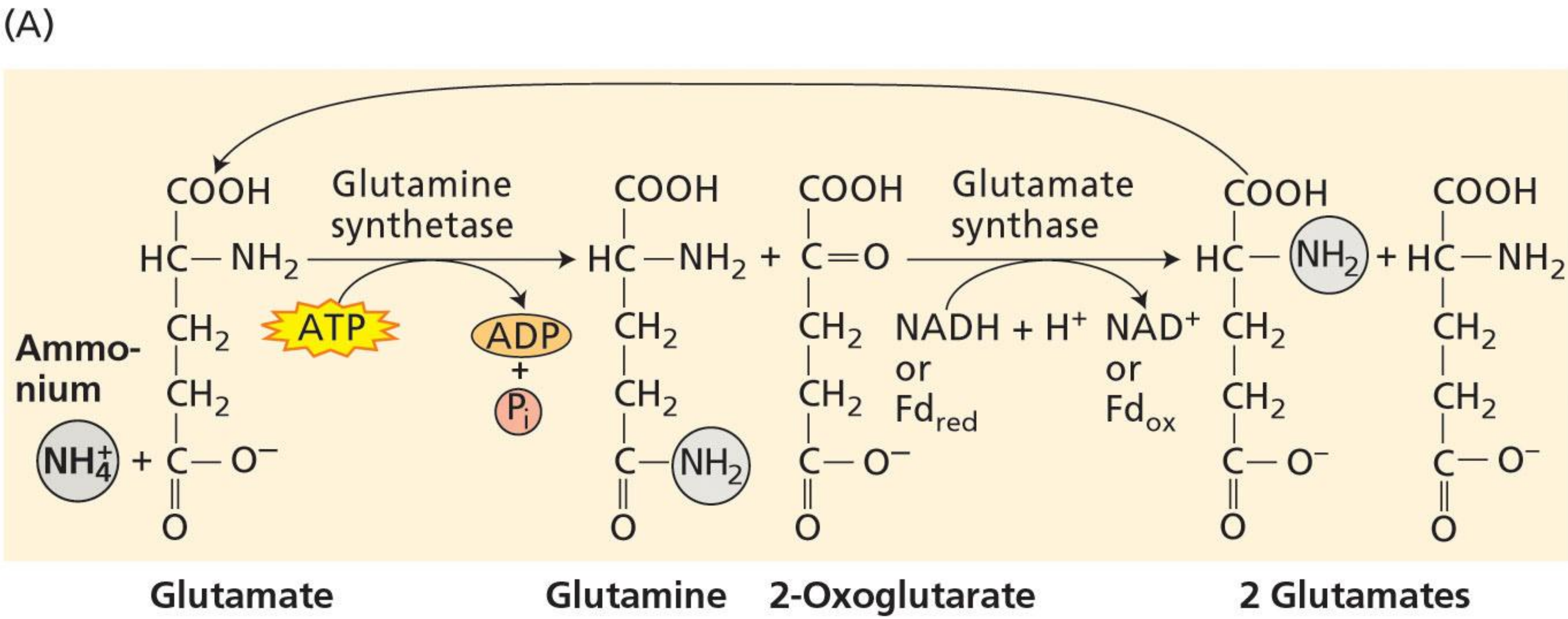


Fig. 10. Glutamate Dehydrogenase Pathway for Ammonium Assimilation

(B)

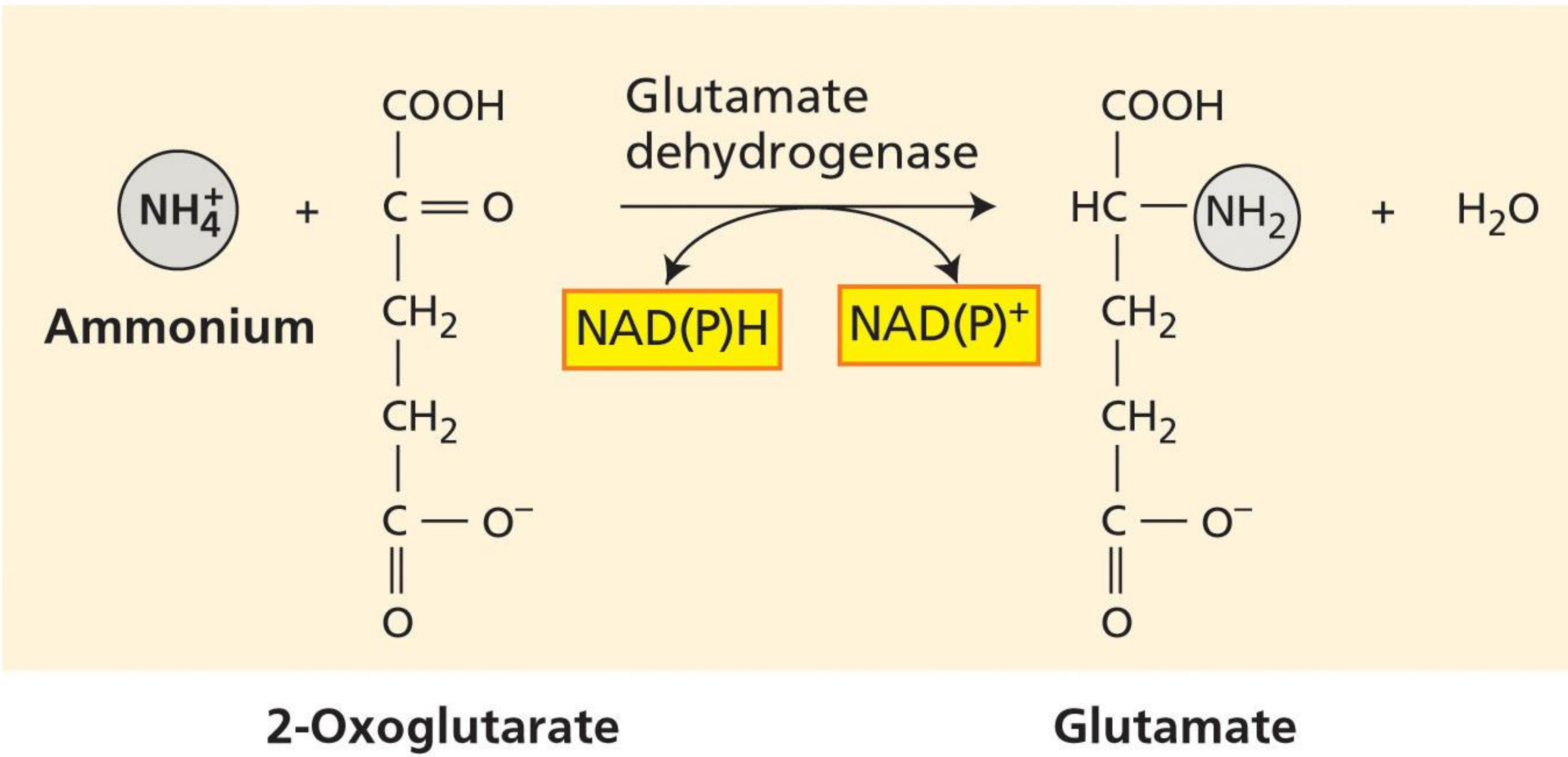
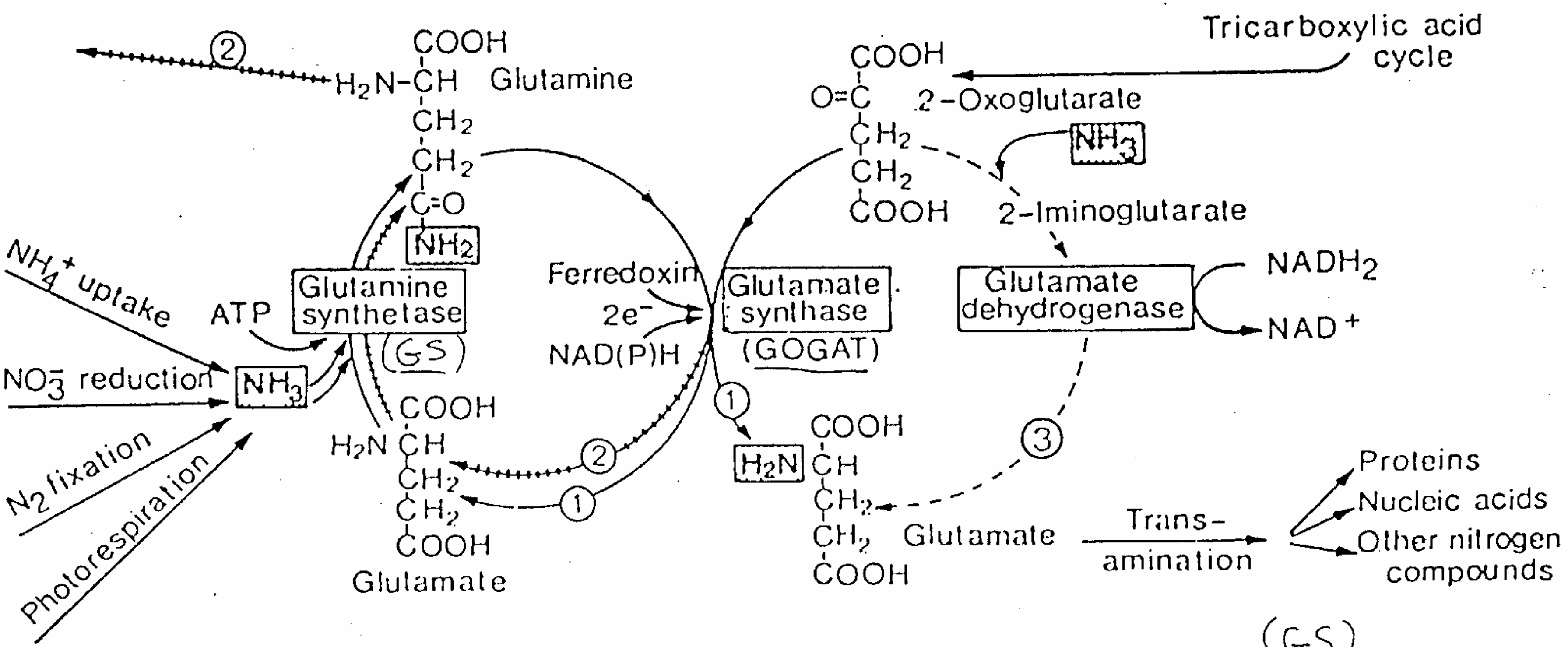


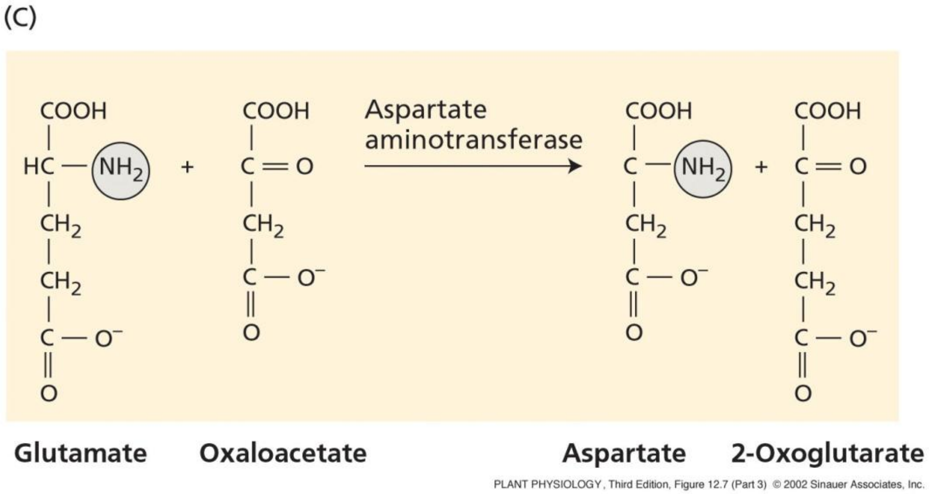
Fig. 11. Model for ammonia assimilation given in Fig. 6.11 of Marschner (2012)



(GS)

Fig. 8.8 Model of ammonia assimilation pathways. (1,2) Glutamine synthetase–glutamate synthase pathway, with low NH_3 supply (1) and with high NH_3 supply (2). (3) Glutamate dehydrogenase pathway. GOGAT, Glutamine-oxoglutamate amino-transferase.

Fig. 12. Glutamate and Glutamine Can Rapidly Be Converted to Aspartate and Asparagine, and Ultimately All Amino Acids Necessary For Protein Synthesis



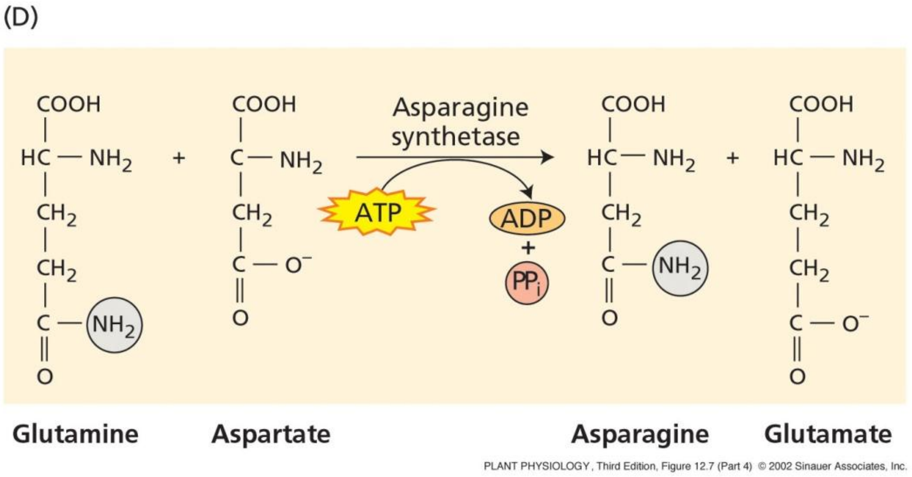


Table 5. Oxo Organic Acids and Their Amino Acid Equivalents

Oxo Acid	**Amino Acid**
2-oxogluterate	Glutamate
Oxalo acetate	Aspartate
Glyoxylate	Glycine
Pyruvate	Alanine
Hydroxypyruvate	Serine
Glutamate-γ-semialdehyde	Ornithine
Succinate semialdehyde	γ-amino-butyrate
A-keto-β-hydroxy butyrate	Threonine